REMARKS

The Office Action dated November 13, 2008, has been received and carefully considered. Reconsideration of the current election/restriction requirement in the present application is respectfully requested based on the following remarks.

I. THE ELECTION/RESTRICTION REQUIREMENT

On pages 3-4 of the Office Action, the Examiner asserts that the present application contains claims directed to three patentably distinct species of the claimed invention: Species I, directed to a horizontal & vertical filter of a direct subband transformer of an encoding system, adaptive histogram updating of an encoding probability estimator of an encoding system, a divider of an entropy encoder of an encoding system, an inverse horizontal filter & vertical filter of an inverse subband transformer of a decoding system, adaptive histogram updating of a decoding probability estimator of a decoding system, and a first divider of an entropy decoder of a decoding system; Species II, directed to a serially coupled direct non-stationary filter of a direct subband transformer of an encoding system, a transformation coefficient C splitter of an encoding probability estimator of an encoding system, a multiplier of an entropy encoder of an encoding system, a serially coupled inverse non-

stationary filter of an inverse subband transformer of a decoding system, a transformation coefficient C builder of a decoding probability estimator of a decoding system, and a multiplier an entropy decoder of a decoding system; and Species III, directed to a second divider of an entropy decoder of a decoding system.

Applicants hereby respectfully traverse this election/restriction requirement, and hereby request that the Examiner reconsider and withdraw this election/restriction requirement. As required, however, Applicants provisionally elect Examiner-alleged generic claims 1-7, 56-62, 113-119, 168-174, 225-231, 280-286, 337-343, 392-398, and 449-452, and Examiner-alleged Species II claims 11-30, 35-39, 42-55, 66-85, 90-94, 100-112, 123-142, 147-151, 154-167, 178-197, 202-206, 212-224, 235-254, 259-263, 266-279, 290-309, 314-318, 324-336, 347-366, 371-375, 378-391, 402-421, 426-430, and 436-448 for prosecution in the event that this election/restriction requirement is made final.

Under 35 U.S.C. § 121, restriction is appropriate if two or more independent and distinct inventions are claimed in one application. As set forth in MPEP § 802.01, inventions are independent if there is no disclosed relationship between the two or more subjects disclosed, and inventions are distinct if

two or more subjects as disclosed are capable of separate manufacture, use, or sale as claimed.

On pages 2-4 of the Office Action, the Examiner attempts to explain how Examiner-alleged Species I-III are distinct from each other. However, the Examiner fails to explain how Examiner-alleged Species I-III are independent from each other. That is, all Examiner-alleged Species I-III are directed to encoding/decoding uncompressed/compressed data. Thus, all Examiner-alleged Species I-X are related and are not independent from each other. Accordingly, it is respectfully submitted that the election/restriction requirement is improper, and the withdrawal of such election/restriction requirement is respectfully requested.

Also, under 37 CFR § 1.141(a), more than one species of an invention may be specifically claimed in different claims in one application, provided that the application also includes an allowable claim generic to all claimed species and all the claims to species in excess of one are written in dependent form or otherwise include all the limitations of the generic claim. It is respectfully submitted, and the Examiner acknowledges, that independent claims 1, 56, 113, 168, 225, 280, 337, and 392 are generic to claimed species. That is, claim 1 is generic to claims 2-55 (which cover Examiner-alleged claimed species I and II), claim 56 is generic to claims 57-112 (which cover all

Examiner-alleged claimed species I-III), claim 113 is generic to claims 114-167 (which cover Examiner-alleged claimed species I and II), claim 168 is generic to claims 169-224 (which cover all Examiner-alleged claimed species I-III), claim 225 is generic to claims 226-279 (which cover Examiner-alleged claimed species I and II), claim 280 is generic to claims 281-336 (which cover all Examiner-alleged claimed species I-III), claim 337 is generic to claims 338-391 (which cover Examiner-alleged claimed species I and II), and claim 392 is generic to claims 393-452 (which cover all Examiner-alleged claimed species I-III). Also, it is respectfully submitted that claims 2-55 (which cover Examiner-alleged claimed species I and II) include all of the limitations of claim 1, claims 57-112 (which cover all Examiner-alleged claimed species I-III) include all of the limitations of claim 56, claims 114-167 (which cover Examiner-alleged claimed species I and II) include all of the limitations of claim 113, claims 169-224 (which cover all Examiner-alleged claimed species I-III) include all of the limitations of claim 168, claims 226-279 (which cover Examiner-alleged claimed species I and II) include all of the limitations of claim 225, claims 281-336 (which cover all Examiner-alleged claimed species I-III) include all of the limitations of claim 280, claims 338-391 (which cover Examiner-alleged claimed species I and II) include all of the limitations of claim 337, and claims 393-452 (which cover all Examiner-

alleged claimed species I-III) include all of the limitations of claim 392. Accordingly, it is respectfully submitted that the election/restriction requirement is improper, and the withdrawal of such election/restriction requirement is respectfully requested.

Furthermore, as shown in the encoder/decoder patent claim mapping chart attached to Applicants' prior response as Appendix A, it is clear that all of the claim sets (i.e., the apparatus claim sets beginning with independent claims 1 and 56, the method claim sets beginning with independent claims 113 and 168, the article of manufacture claim sets beginning with independent claims 225 and 280, and the signal claim sets beginning with independent claims 337 and 392) share common elements and features, and thus it would not be unduly burdensome for the Examiner to examine all of the pending claims. Additionally, Applicants' note that the European Patent Office didn't question a single inventive concept of the PCT application PCT/YU2003/000027, published as WO2004028142A3 with International Preliminary Search Report and unpublished International Preliminary Examination report, in its First Office Action. Additionally still, the same aforementioned PCT application PCT/YU2003/000027 resulted in a granted patent ZL03825219.8, issued by the China Patent & Trademark Office and published as CN100401778C on July 9, 2008. All apparatus and

method claims 1-224 were granted, while article of manufacture and signal propagation type of claims, such as 225-452, cannot be granted in The People's Republic of China. Additionally still, the Intellectual Property Office of the Republic of Serbia also issued Patent No. 49934 on March 11, 2008, based on the appropriate priority patent application P-696/02 in the PCT Chapter II National Phase, from which the same aforementioned PCT application PCT/YU2003/000027 originates. All apparatus and method claims 1-224 were granted, while article of manufacture and signal propagation type of claims, such as 225-452, cannot be granted in the Republic of Serbia. Accordingly, it is respectfully submitted that the election/restriction requirement is improper, and the withdrawal of such election/restriction requirement is respectfully requested.

At this point Applicants would like to note that the encoder and the decoder as disclosed in the present patent application provide at least the following features:

- mathematically lossless or lossy compression
- still image and intraframe (I-frame) video compression
- integer arithmetics without multiplication and division operations
- symmetrical compression and decompression with the same number of frames per second
- symmetrical compression and decompression with the same very low latency being less than one frame (8 lines of a single frame)
- several orders of magnitude smaller compression and decompression memory requirements, being approximately 3 lines of a single frame, instead of many frames required by

state-of-the-art methods, thus providing most operations from the microprocessor's cache

- orders of magnitude faster compression in comparison with state-of-the-art methods, which will be even faster on future multicore processors according to the enclosed reference 4), due to a memory bottleneck of state-of-the-art data intensive methods
- order of magnitude faster decompression in comparison with state-of-the-art methods, which will be even faster on future multicore processors according to the enclosed reference 4), due to a memory bottleneck of state-of-the-art data intensive methods
- smaller bit rate for the same quality than best state-of-the-art still image and intraframe (I-frame) video compression methods
- similar bit rate for the same quality as best state-of-the-art interframe (IPB-frames) video compression methods for UAV video, movies, music spots and sport events.
- scalability for resolution, i.e. inherent extraction of lower resolutions from higher resolution bit stream
- scalability for quality, i.e. inherent extraction of lower quality images from higher quality images
- temporal scalability, i.e. dropping of any number of frames in either encoder or decoder
- huge processing power savings due to all previous features
- significantly higher error resilience due to I-frames and inherent simple error concealment
- inherent parallelism due to encoding or decoding of subsequent frames on separate CPU cores
- several orders of magnitude lower cost of the implementation of the encoder chip in comparison with state-of-the-art methods
- order of magnitude lower cost of the implementation of the decoder chip in comparison with state-of-the-art methods

In a nutshell, the claimed invention provides the full set of aforementioned features due to the following major inventive steps:

1) Memory buffers between major processing blocks of the Fast Encoder: direct filters, probability estimators and entropy encoders may be eliminated. Furthermore, just two lines of an input frame may be necessary to be buffered before the start of the compression.
2) Direct filters may be non-stationary filters for the recursive octave direct subband transformer with time-varying filtering structure instead of being linear filters with constant coefficients, thus decreasing filter complexity and memory requirements.
3) Context modeling may be used for both magnitude and sign of transformation coefficients, instead of for magnitude only, thus improving compression ratio.
4) Probability estimation may be performed on-the-fly as pixels are coming using a minimum number of histograms with fast adaptation for both magnitude and sign of transformation coefficients, instead of waiting for a memory fill with data, thus saving memory and decreasing latency.
5) The entropy encoder may be an improved range encoder without multiplications and divisions, due to the utilization of context modeling and symbol probability estimation.
6) Memory buffers between major blocks of the Fast Decoder: entropy decoders, probability estimators and inverse filters may be eliminated. Furthermore, just two lines of an output frame may be necessary to be buffered before the start of the decompression.
7) Inverse filters may be non-stationary filters for the recursive octave inverse subband transformer with time-varying filtering structure instead of being linear filters with constant coefficients, thus decreasing filter complexity and memory requirements.
8) Context modeling may be used for both magnitude and sign of transformation coefficients, instead of for magnitude only, thus improving compression ratio.
9) Probability estimation may be performed on-the-fly as pixels are delivered using a minimum number of histograms with fast adaptation for both magnitude and sign of transformation coefficients, instead of waiting for a memory fill with data, thus saving memory and decreasing latency.
10) The entropy decoder may be an improved range decoder without multiplications and divisions, due to the utilization of context modeling and symbol probability estimation.

A detailed analysis of the present patent application shows that the proper operation and the full set of aforementioned features of the Fast Encoder and the Fast Decoder provided by the claimed invention may not be fulfilled if any of the blocks of the Fast Encoder and the Fast Decoder are missing or made differently from the preferred embodiments. For example, multiplication and division operations in the entropy encoder and the entropy decoder may be avoided due to the appropriate total number of symbols, being the power of two, as provided by the probability estimation block. Also, multiplication and division operations in direct and inverse filters may be avoided due to a specific choice of a power of two coefficients and the non-stationary structure of filters. Further, fast on-the-fly compression of pixels with minimal latency using minimal memory requirements may be possible in the Fast Encoder due to a specific realization and tight coupling of direct filters, probability estimators and entropy encoders, as well as the removal of memory buffers. Additionally, fast on-the-fly decompression of pixels with minimal latency using minimal memory requirements may be possible in the Fast Decoder due to a specific realization and tight coupling of entropy decoders, probability estimators and inverse filters, as well as the removal of memory buffers. Additionally still, the Fast Encoder and the Fast Decoder may provide exact direct and inverse

operations in order to properly encode and decode data in the proper order.

A detailed description of the interdependence of claims will be described using the apparatus claims (1-112), while the appropriate descriptions may be valid for substantially the same method claims (113-224), article of manufacture claims (225-336, 449 and 450), and propagated signal claims (337-448, 451 and 452).

For the Encoding System:

a) Direct subband transformer

Horizontal direct filtering (claim 6) may be used for the compression of one-dimensional signal, such as audio. Both horizontal direct filtering and vertical direct filtering (claims 7 to 9 and Fig. 29) may be used for the compression of two-dimensional signal, such as image or video.

A direct non-stationary filter (claim 10) may be a preferred embodiment of both a horizontal direct filter and a vertical direct filter in order to provide the full set of aforementioned features of the Fast Encoder.

In order to provide a common set of claims for the compression of both one-dimensional and two-dimensional signals, various embodiments of a direct non-stationary filter based on the same inventive concept may be covered by a separate set of

claims 11 to 30, starting from the direct filter (claim 11), through the direct non-stationary filter (claim 12) to serially coupled direct non-stationary filter cells (claim 13), which are claimed in a general form (claims 14 to 21, and Figs. 17, 18 and 19), as well as a first order device (claims 22 to 26 and Fig. 21), a second order device (claims 27 to 30 and Fig. 23), while third embodiment (Fig. 27) has not been claimed in order to decrease number of claims.

Multipliers in direct non-stationary filters may be preferably realized using shifting means according to claims 19, 21, 23, 24, 25, 28 and 29, in order to provide the full set of aforementioned features of the Fast Encoder.

The aforementioned description of the interdependence of claims shows that the horizontal direct filter and the vertical direct filter named Species I in the Office Action, and the direct non-stationary filter, as well as serially coupled direct non-stationary filter cells, named Species II in the Office Action are not distinct mutually exclusive species of a direct subband transformer. On the contrary, the direct non-stationary filter may be a preferable embodiment of both the horizontal direct filter and the vertical direct filter, and may be necessary in order to provide the full set of aforementioned features of the Fast Encoder.

b) Encoding probability estimator

Fig. 31 is a flowchart of the encoding probability estimator and entropy encoder of the claimed invention based on single-pass adaptive histograms.

A transformation coefficient *C* splitter (3102) may provide both magnitude *M* and sign *S* of a transformation coefficient *C* to a magnitude-set index *MS* determinator and a residual *R* determinator (claim 42), wherein a context modeler of a transformation coefficient *C* to be encoded (claims 45 and 46 and Figs. 32 and 33) through a mean value $\overline{MS}$ determinator may provide a mean value $\overline{MS}$ (claims 47 to 48) to adaptive magnitude histogram $h[MC]$ updating means (claim 50 and processing block 3109) and through a ternary context *TC* determinator may provide a ternary context *TC* (claim 51) and a sign context *SC* (claim 53) to adaptive sign histogram $g[SC]$ updating means (claim 55 and processing block 3117).

In order to provide a common set of claims for both adaptive magnitude histogram $h[MC]$ updating means (claim 50 and processing block 3109) and adaptive sign histogram $g[SC]$ updating means (claim 55 and processing block 3117), embodiments of adaptive histogram updating means may be covered by a separate set of claims 31 to 34 and Figs. 35 and 36.

The aforementioned description of the interdependence of

claims shows that adaptive histogram updating means named Species I in the Office Action, and transformation coefficient C splitter named Species II in the Office Action, are not distinct mutually exclusive species of encoding probability estimator, but may be tightly coupled processing blocks (3102, 3109 and 3117) of the encoding probability estimator (Fig. 31), and may be necessary in order to provide the full set of aforementioned features of the Fast Encoder.

c) Entropy (range) encoder

Fig. 31 is a flowchart of the encoding probability estimator and entropy encoder of the claimed invention based on single-pass adaptive histograms. The range encoder (Figs. 39 and 38) employs the divider (3911) and two multipliers (3912 and 3915).

The range encoder may be preferably realized with simplified multiplication and division operations or even without multiplication and division operations (Figs. 41A, B) in order to provide the full set of aforementioned features of the Fast Encoder.

In order to provide common set of claims for both the magnitude range encoder (3108) using adaptive magnitude histogram $h[MC]$ (claim 49), and the sign range encoder (3116)

using adaptive sign histogram $g[SC]$ (claim 54), the embodiments of an improved range encoder (Figs. 41A,B) may be covered by claims 35 to 41.

The embodiments of the entropy encoder with simplified multiplication operations may be covered by claims 35 to 36, while the embodiments of the entropy encoder without multiplication operations may be covered by claims 37 to 39.

The embodiment of the entropy encoder with simplified division operation may be covered by claim 40, while the embodiment of the entropy encoder without division operation may be covered by claim 41.

The aforementioned description of the interdependence of claims shows that a divider named Species I in the Office Action, and a multiplier named Species II in the Office Action are not distinct mutually exclusive species, but may be tightly coupled processing blocks (3911, 3912 and 3915) of the same range encoder (Fig. 39), and may be necessary in order to provide the full set of aforementioned features of the Fast Encoder.

For the Decoding System:

a) Inverse subband transformer

Horizontal inverse filtering (claim 61) may be used for the decompression of one-dimensional signal, such as audio. Both

horizontal inverse filtering and vertical inverse filtering (claims 62 to 64 and Fig. 30) may be used for the decompression of two-dimensional signal, such as image or video.

An inverse non-stationary filter (claim 65) may be a preferred embodiment of both a horizontal inverse filter and a vertical inverse filter in order to provide the full set of aforementioned features of the Fast Decoder.

In order to provide a common set of claims for the decompression of both one-dimensional and two-dimensional signal, various embodiments of an inverse non-stationary filter based on the same inventive concept may be covered by a separate set of claims 66 to 85, starting from the inverse filter (claim 66), through the inverse non-stationary filter (claim 67) to serially coupled inverse non-stationary filter cells (claim 68), which are claimed in a general form (claims 69 to 76, and Figs. 17, 18 and 20), as well as a first order device (claims 77 to 81 and Fig. 22), a second order device (claims 82 to 85 and Fig. 24), while third embodiment (Fig. 28) has not been claimed in order to decrease number of claims.

Multipliers in inverse non-stationary filters may be preferably realized using shifting means according to claims 74, 76, 78, 79, 80, 83 and 84, in order to provide the full set of aforementioned features of the Fast Decoder.

The aforementioned description of the interdependence of

claims shows that the horizontal inverse filter and the vertical inverse filter named Species I in the Office Action, and the inverse non-stationary filter, as well as serially coupled inverse non-stationary filter cells, named Species II in the Office Action are not distinct mutually exclusive species of an inverse subband transformer. On the contrary, the inverse non-stationary filter may be a preferable embodiment of both the horizontal inverse filter and the vertical inverse filter, and may be necessary in order to provide the full set of aforementioned features of the Fast Decoder.

b) Decoding probability estimator

Fig. 34 is a flowchart of the decoding probability estimator and entropy decoder of the claimed invention based on single-pass adaptive histograms.

A transformation coefficient *C* builder (3416) may reconstruct a transformation coefficient *C* from a magnitude-set index *MS*, a sign *S* and a residual *R* (claim 100), wherein a context modeler of a transformation coefficient *C* to be decoded (claims 102 and 103 and Figs. 32 and 33) through a mean value $\overline{MS}$ determinator may provide a mean value $\overline{MS}$ (claims 104 to 105) to adaptive magnitude histogram $h[MC]$ updating means (claim 107 and processing block 3405) and through a ternary context *TC*

determinator may provide a ternary context TC (claims 108) and a sign context SC (claim 109) to adaptive sign histogram $g[SC]$ updating means (claim 111 and processing block 3411).

In order to provide a common set of claims for both the adaptive magnitude histogram $h[MC]$ updating means (claim 107 and processing block 3405), and the adaptive sign histogram $g[SC]$ updating means (claim 111 and processing block 3411), embodiments of adaptive histogram updating means may be covered by a separate set of claims 86 to 89 and Figs. 35 and 36.

The aforementioned description of the interdependence of claims shows that adaptive histogram updating means named Species I in the Office Action, and transformation coefficient C builder named Species II in the Office Action are not distinct mutually exclusive species of decoding probability estimator, but may be tightly coupled processing blocks (3405, 3411 and 3416) of the decoding probability estimator (Fig. 34), and may be necessary in order to provide the full set of aforementioned features of the Fast Decoder.

c) Entropy (range) decoder

Fig. 34 is a flowchart of the decoding probability estimator and entropy decoder of the claimed invention based on single-pass adaptive histograms. The range decoder (Fig. 40)

employs two dividers (4006 and 4007) and two multipliers (4011 and 4014).

The range decoder may be preferably realized with simplified multiplication and division operations or even without multiplication and division operations (Figs. 42) in order to provide the full set of aforementioned features of the Fast Decoder.

In order to provide a common set of claims for both the magnitude range decoder (3404) using adaptive magnitude histogram $h[MC]$ (claim 106) and the sign range decoder (3410) using adaptive sign histogram $g[SC]$ (claim 110), the embodiments of an improved range decoder (Fig. 42) may be covered by claims 90 to 99.

The embodiments of the entropy decoder with simplified multiplication operations may be covered by claims 90 to 92, while the embodiments of the range encoder without multiplication operations may be covered by claims 92 to 94.

The embodiments of the range decoder with simplified division operations may be covered by claims 95, 97 and 98, while the embodiments of the range decoder without division operations may be covered by claims 96 and 99.

The aforementioned description of the interdependence of claims shows that a first divider named Species I in the Office

Action, a multiplier named Species II in the Office Action, and a second divider named Species III in the Office Action are not distinct mutually exclusive species, but may be tightly coupled processing blocks (4006, 4011 and 4007) of the same range decoder (Fig. 40), and may be necessary in order to provide the full set of aforementioned features of the Fast Decoder.

At this point Applicants would like to note that any search and examination burden mentioned in the Office Action may be significantly decreased due to the detailed prior art search performed by the European Patent Office, the China Patent & Trademark Office, and the Intellectual Property Office of the Republic of Serbia, as well as the extensive Background Art section of the present patent application.

Accordingly, it is respectfully submitted that the election/restriction requirement is improper, and the withdrawal of such election/restriction requirement is respectfully requested.

II. CONCLUSION

In view of the foregoing, it is respectfully submitted that the present application is in condition for allowance, and an early indication of the same is courteously solicited. The Examiner is respectfully requested to contact the undersigned by telephone at the below listed telephone number, in order to

expedite resolution of any issues and to expedite passage of the present application to issue, if any comments, questions, or suggestions arise in connection with the present application.

To the extent necessary, a petition for an extension of time under 37 CFR § 1.136 is hereby made.

Please charge any shortage in fees due in connection with the filing of this communication to Deposit Account No. 50-0206, and please credit any excess fees to such deposit account.

Respectfully submitted,

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